

REDUCING THE EFFECTS OF NOISE IN NON-VOLATILE MEMORIES THROUGH MULTIPLE READS

ABSTRACT OF THE DISCLOSURE

5 Storage elements are read multiple times and the results are accumulated
and averaged for each storage element to reduce the effects of noise or other transients in
the storage elements and associated circuits that may adversely affect the quality of the
read. Several techniques may be employed, including: A full read and transfer of the
10 data from the storage device to the controller device for each iteration, with averaging
performed by the controller; a full read of the data for each iteration, with the averaging
performed by the storage device, and no transfer to the controller until the final results are
obtained; one full read followed by a number of faster re-reads exploiting the already
established state information to avoid a full read, followed by an intelligent algorithm to
15 guide the state at which the storage element is sensed. These techniques may be used as
the normal mode of operation, or invoked upon exception condition, depending on the
system characteristics. A similar form of signal averaging may be employed during the
verify phase of programming. An embodiment of this technique would use a peak-
detection scheme. In this scenario, several verify checks are performed at the state prior
20 to deciding if the storage element has reached the target state. If some predetermined
portion of the verifies fail, the storage element receives additional programming. These
techniques allow the system to store more states per storage element in the presence of
various sources of noise.